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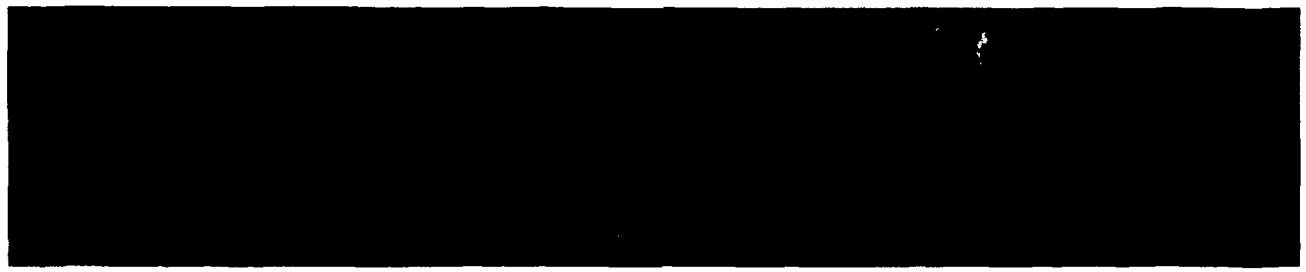

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PM TRADE
DARPA

January 15-17, 1990

Summary Report

The Second Conference on Standards for the Interoperability of Defense Simulations Volume I: Minutes

Institute for Simulation and Training
12424 Research Parkway, Suite 300
Orlando FL 32826

University of Central Florida
Division of Sponsored Research

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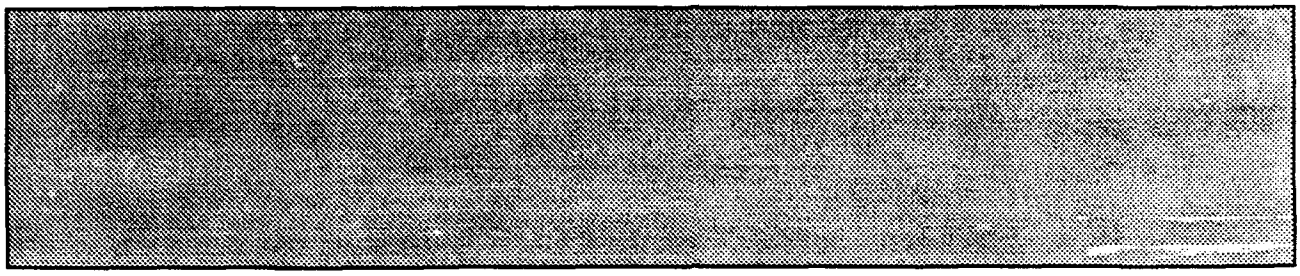

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Volume I: Minutes

A-1

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Bob Glasgow
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Bruce McDonald
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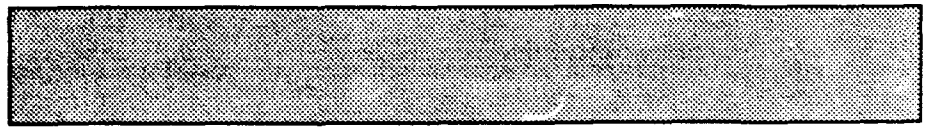

This report is informational and does not express the opinions of PM TRADE or DARPA.

Institute for Simulation and Training
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This report presents a summary of the activities of the Second Conference on Standards for the Interoperability of Defense Simulations sponsored by the Defense Advanced Research Projects Agency (DARPA) and the Program Manager for Training Devices (PM TRADE). The workshop was hosted by the University of Central Florida/Institute for Simulation and Training (UCF/IST) on 15-17 January, 1990.

This volume contains summaries of all presenters' speeches.

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SUMMARY REPORT

The Second Conference on Standards for the Interoperability of Defense Simulations

January 15-17, 1990 Orlando, FL

1.0 INTRODUCTION

This report presents a summary of the activities of the Second Conference on Standards for the Interoperability of Defense Simulations sponsored by the Defense Advanced Research Projects Agency (DARPA) and the Program Manager for Training Devices (PM TRADE). The workshop was hosted by the University of Central Florida/Institute for Simulation and Training (UCF/IST) on 15-17 January 1990, in Orlando, Florida.

This is the second workshop concerning the development of technical standards for networking defense simulations. These standards are intended to meet the needs of large scale simulated engagements systems which are increasingly being used to support system acquisition, testing and evaluation, and tactical warfare simulation and training in the Department of Defense (DoD). The primary goals of this workshop were to provide a forum to discuss issues prior to the development of a Protocol Data Unit (PDU) level standard, to capture networking requirements and needs, to exchange ideas, and to keep interested parties informed on networking technology issues.

The three day workshop focused on two major topic areas: Communication Protocols and Terrain Databases. The Communication Protocols Working Group was headed by Dr. Ron Hofer, Chief of Engineering, PM TRADE. This group was mainly concerned with what information is transmitted between simulators and was divided into the following subgroups:

- Interface
- Time/Mission Critical
- Security
- Long Haul/Wide Band
- Non Visual

The Terrain Databases Working Group was headed by George Lukes, Director of the Center for Autonomous Technologies, U. S. Army Engineer Topographic Laboratory. This group was mainly concerned with how the terrain data is interpreted and was divided into the following subgroups:

- Correlation
- Dynamic Terrain
- Unmanned Forces
- Interim Terrain Database

In response to comments made at this workshop, a new subgroup is being formed to address Human Performance Measures. This subgroup will address requirements for recording and assessing operator performance in the simulators on the network. As part of this effort, issues concerning instructor interfaces for controlling exercises and evaluating student performance will be addressed. User inputs about needed capability for networked simulators will be solicited. Dr. Bruce McDonald of the Institute for Simulation and Training will chair this subgroup, and any comments and suggestions should be directed to him.

This report is published in three volumes. Volume I contains summaries of all presenters' speeches. Volume II contains an attendees list, a copy of the view graphs used during presentations, and a copy of all documents that were submitted at the conference for the attendees' information. Volume III contains a copy of all position papers received by UCF/IST as of February 15, 1990.

2.0 COMBINED SESSION - SPEAKER SUMMARIES
Tuesday, January 16, 1990

2.1 Opening Comments.

Mr. Brian Goldiez of IST offered opening greetings and general announcements for the conference. Mr. Paul Chatelier (NSIA) gave a short description of the role of NSIA, and manpower and training involvement in the conference. Dr. Richard Astro (UCF) welcomed the conference presenters and attendees.

2.2 Opening Conference Presenters.

Barry Boehm, James O'Bryon, James Shiflett, Brian Goldiez, Lee Rogers, Larry Welsch, and Robert Glasgow gave presentations of general issues on the standardization of simulation.

2.2.1 Dr. Barry Boehm. Director of Information, Science & Technology Office, DARPA.

In his opening address, Dr. Boehm stressed the importance of standardization. He stated three main reasons for standards:

1. Software Economics. Because the Department of Defense's software needs have grown, it is concerned with the ability to buy more for less. By using cost estimation models, the future costs of software projects can be determined. The primary driver of software cost is lines of code.

2. Validating Weapons Systems Concepts. With standards, you have the ability to implement interfaces, and validate experimental concepts.

3. Growing Room for A System. Interface standards provide growing room for your system by allowing you to interoperate simulators with both real equipment and analytical simulations. Although this poses a problem of system bandwidth requirements, intelligent gateways and subsetting to the different areas of importance can overcome the problem.

2.2.2 Mr. James F. O'Bryon. Director Live Fire Testing, Office of Deputy Undersecretary of Defense (Acquisition).

Mr. O'Bryon discussed how simulation is essential for live fire testing. Flaws can be discovered and corrected before production. The ultimate goal is to create and maintain a defense simulation standard that will eventually enjoy consensus across the military forces, industry and the world.

Mr. O'Bryon discussed the definition of simulation and the role that DARPA has played in creating a new plateau for simulation. The goal is to make a timeless, seamless, virtual battlefield

simulation that is interoperable with another simulation.

Mr. O'Bryon placed emphasis on weapons acquisition testing and on the acquisition cycle. He specifically made a case for joint forces (Army, Navy, Air Force) man-in-the-loop simulation. Mr. O'Bryon also stressed the need for commonality of simulators in industry and DoD. The Department of Defense recognizes the need for standards to assure that everything works together in an efficient manner. Because the defense budget may be cut by 39 billion dollars, standardization is becoming essential.

Mr. O'Bryon discussed the requirements for live fire and stated several reasons why test simulation should be performed before actual firing. If the services tell the testers what is expected to happen, they will know what damage is expected. The services need to evaluate how good the simulations really are and to help sequence the test.

He stated several reasons for the contribution of seamless simulation to testing and evaluation. These include cost cuts, pretesting concepts, evaluation of alternatives, and testing plans.

Mr O'Bryon closed with a discussion of the problems involved in effecting change. These included impatience, resistance, parochialism, and superficiality.

2.2.3 LTC(P) James Shiflett. Program Manager, ISTO, DARPA.

LTC(P) Shiflett discussed a new SIMNET system that has not yet been developed. The system will be used to train and develop the techniques and tactics needed to fully employ that system. He stressed the human-in-the-loop aspect.

Shiflett stressed the need for interoperable simulations. Every simulator needs a common view of the world so that interoperability makes a smooth transition. For the future, he encourages all systems to be interoperable. In the future, the services will meet, discuss their objectives and then participate in their exercises. This must be incorporated into the simulation environment.

2.2.4 Mr. Brian Goldiez. University of Central Florida, Institute for Simulation and Training.

Mr. Goldiez opened his presentation with a discussion of the steering committee's actions. He stated that the conference participants had evolved into two main groups, and briefly discussed the distinctions between them.

With the goal of developing a military standard with Protocol Data Unit descriptions by December 1990, Mr. Goldiez then discussed IST's, The National Institute of Standards and Technology's, and the DoD's roles in the development of the standard:

1) IST will write the standard. It will take input from this conference until the 15th of February and complete a draft by May 30, 1990.

2) NIST will help identify ongoing efforts in the private sector, and determine their appropriateness.

3) The DoD will serve as a custodian.

Mr. Goldiez then discussed IST's assessment of DoD/industry needs and the critical subsystem issues.

DOD/industry needs:

- Multi-level interoperability.
- Clearly defined interfacing methods. (The PDUs will help in this.)
- Clearly defined performance parameters/tools.
- Open architecture.
- Expandable system performance. ("Technology is moving too fast to lock yourself in.")

Critical Subsystem Issues:

- PDU definition
- Interface ability with existing standards
- Network requirements

2.2.4.1 Standards Process Panel. Mr. Goldiez then introduced the Standards Process Panel consisting of Lee Rogers, Larry Welsch, Robert Glasgow, and Steve Sarner. Following are summaries of their discussions:

Mr. Lee Rogers, Office of Secretary of Defense (OSD). Mr. Rogers discussed OSD responsibilities for DoD standards, and the process that is involved. He stated that there is an order of preference within the DoD, and what is most and least significant needs to be determined. PM TRADE will serve as the focal point within the DoD for this program. They will obtain project numbers, authorize coordination, and maintain and approve documents.

Mr. Larry Welsch, NIST. Mr. Welsch discussed the need to reduce the cost of producing standards. The discussion centered on the use of remote procedure calls instead of PDUs.

Mr. Robert Glasgow, IST. Mr. Glasgow discussed using the SIMNET protocol as the baseline for a standardized protocol data unit. He emphasized that the standard protocol must be adaptable for all applications, including land-based, air, and sea. The ensuing discussion revolved around what is necessary to improve the SIMNET protocol before if can be incorporated into a standard. Improvement areas include higher order dead reckoning models and the capability for simulating intelligent weapons systems.

Breakout Sessions. The assembly divided into two working groups following the luncheon:

1. Terrain Databases Working Group
2. Communications Protocols Working Group

3.0 TERRAIN DATABASES WORKING GROUP.

3.1 Introductory Presentations.

Introductory presentations on Dynamic Terrain, Correlation, and Geodetic Frame of Reference were presented by Richard Moon, Duncan Miller, Pete Weaver, and Steve Smyth.

3.1.1 Dynamic Terrain. Mr. Richard Moon of Evans and Sutherland discussed dynamic terrain issues and how they are not yet highly developed. The main problem with dynamic terrain is how to dynamically position micro-terrain. This has proven to be very difficult on today's Computer Image Generator architectures. The data has to be changed in RAM, and then put back on disk.

Object Oriented Hierarchical Terrain Database issues were identified, including class hierarchy, message protocols and bulldozer scenarios. The problem with computational loads also still exists. Three approaches for networking were identified, including self-responsibility, viewer responsibility and centrally computed dynamics.

The program of research areas were identified as the following: object oriented databases, experiments with automated LOD extraction, analysis of distributed computed schemes, and special purpose architectures.

3.1.2 Correlation. Dr. Duncan Miller of Bolt, Beranek and Newman (BBN), Chairman of the Correlation Sub-Group, spoke on SIMNET Database Interchange Specification. The goal, he said, is to present machine independent representation of the terrain data so that the focus can be on database interoperability.

3.1.2.1 Database Interoperability. In order to have database interoperability, terrain databases must agree on:

- communication
- protocol
- information shared
- the geometric shape of the world they share.

3.1.2.2 Geometric Shape of the Simulators' World. Concerns expressed about the geometric shape of the world shared in the terrain databases included minimizing anomalies and line of sight correlation.

3.1.2.3 Fort Knox Study. Mr. Pete Weaver of BBN discussed work that has been done at Fort Knox. They did a study using databases that had known, measured differences to see what effects would occur, especially with regard to anomalies and line of sight correlation.

3.1.2.4 Correlation Measures. The types of measures used in the Fort Knox study were geometry correlation, vertical correlation

(computed using a difference model), and intervisibility equivalence, which involves looking at actual terrain, and not the features. Correlation measures are useful in designing systems and building databases to prevent players from not participating in simulations because their databases are not interoperable.

3.1.2.5 SIMNET Database Study. A study was performed using the Hunter-Liggettt SIMNET database. A low grid sample database was created by throwing away every other point. This caused the two databases to differ too much to interoperate. At this time, Mr. Weaver showed a five minute video of the results from the study.

3.1.2.6 Models Defined for Correlation. There are several models that are defined for correlation. One is the Difference model where one terrain surface and another terrain surface are subtracted to create a new surface. Analysis of the new surface (e.g. distribution of points) can then be performed.

Another model is the Intervisibility model. Intervisibility correlation attempts to measure the consistency of view between two databases. When a person looks at the same location on both databases, is there agreement on what is seen? The number of points between the two databases that agree can be measured.

3.1.2.7 Conclusions. Several conclusions were drawn at this point. One was that high geometric correlation is required for interoperability, but a determination needs to be made to enforce a good level of intervisibility correlation.

3.1.3 Geodetic Frame of Reference. Next, Mr. Steve Smyth of BBN gave a presentation on Geodetic Frame of Reference. The discussion centered around a position paper submitted by Mr. Smyth and Mr. Burchfiel. (Please reference Volume III of the minutes for explicit details.)

3.1.3.1 Position Paper. Mr. Smyth presented a method for using a geodetic coordinate system to communicate position within and between simulators. He stated that the geodetic reference system was the current accepted scheme used to agree on the description of position on the earth's surface. It uses a pair of angles and a height to describe the position. The Geodetic Latitude angle is the angle between the surface normal and the plane of the equator. The Geodetic longitude is the angle that is between: a) the line that runs out from the center of the earth from the projected line on the equatorial plane surface normal and the plane of the normal, and b) the projection of the prime meridian.

3.1.3.2 SIMNET Cartesian System. The systems that the DoD currently use is WGS-84. Mr. Smyth then discussed the SIMNET database coordinate system (Cartesian), and how new requirements are demanding a better representation.

3.1.3.3 Costs for Processing Packets. A question was raised at this point about the computational costs for processing packets. Mr. Smyth answered that they had evaluated the cost factors between several coordinate systems, and that the cost of approach was determined to be 50 to 80 floating point operations per conversion, not considered to be a significant expense.

3.1.3.4 Conclusions. The group summed up with some agreed-upon requirements, including the fact that simulations need to communicate position by using some kind of global coordinate system, and the appropriate choice was the geodetic reference system.

3.2 Subgroups.

The Terrain Databases Working Group broke up into the subgroups of Correlation, Dynamic Terrain, Unmanned Forces, and Interim Terrain Databases. Summaries of their discussions appear below.

3.2.1 Correlation Subgroup. This group discussed the following issues related to correlation:

3.2.1.1 Pair Wise Comparison. Dr. Duncan Miller discussed correlation issues and stressed the importance of pair-wise comparison of points in the two databases. There are three types of comparisons that can be made:

a) The determination of how many points are visible in both databases.
b) The determination of how many points are not visible in both databases.
c) The determination of how many points are visible in one database, but not visible in the other database.

3.2.1.2 Budgeting Polygons. The question of interoperability revolves around budgeting polygons so that the high resolution flight simulators can track and see objects on the ground. A metric is needed for describing how geometrically different the two processors are, and a determination must be made as to which conforms to the other.

3.2.1.3 Miscellaneous Issues.

a) The group prioritized the goals of correlation.

b) The artifacts of the simulation should not be known and used to create an advantage during the simulation exercises, especially for high to low fidelity simulation exercises.

c) How good is "good enough" must be determined.

d) It is possible to have interoperability without having complete agreement among the databases. Therefore, the real

issue is how to deal with the differences, and how to make sense of it through tools.

3.2.1.4 Conclusions. At the conclusion of the session, it was agreed that specifying a standard is not feasible at this time. However, some things can be defined, including how many other vehicles each simulator needs to see. It is suggested from past experience that they need to see approximately 50 other vehicles.

Interoperability requires not only an agreement on the number of vehicles that can be seen, but also on prioritization By prioritization, it is meant that if there are 50 other objects out there, you might only see the 35 that are the most necessary for you to see. This is performed using prioritization algorithms.

Wednesday, 17 January, 1990

3.2.1.5 Opening Discussion. The session began with a discussion of different algorithms that can be used to correlate databases. Again, it was stressed that a decision needs to be made as to what degree the two databases need to correlate. An example given of poor correlation was the demonstration done at the I/ITSC, where a McDonnell Douglas Aircraft simulator and a Paragon display were networked using the SIMNET display. An air-to-air combat display was performed using both a simple and a complex model of the terrain. Although they didn't correlate well, it was shown to be a useful exercise.

3.2.1.6 SIMNET Software Case Study. A case study discussed was a new software release for SIMNET that has been sent out for field testing. The software contained improved terrain texture features. The results revealed that the new terrain texture was changing the detectability of the targets at different ranges. As a result, a fairly detailed study was conducted to measure the differences. In the study, target vehicles-- both friendly and hostile-- were placed on the terrain at various points. A study was then made using various subjects to determine what fraction of the tanks were identified properly, what fraction of the tanks were detected at all, and what fraction of those identified properly where actually hit. The point of the discussion was to stress that certain things are important operationally in an exercise: to be able to see and identify targets, and to be able to identify them using simulated real-world operational measures.

3.2.1.7 Problems.

a) The problem of having different levels of image generation is always going to exist. If the data structure approach is taken, it will always have to serve the needs of the highest level of detail, causing problems with lower levels.

Studies need to be performed on the amount of correlation that is necessary, and at what point the simulation breaks down.

b) If a common database is used, many problems involving correlation issues would go away. However, motion and navigation issues would still need to be addressed, and implementing them would require substantial investment.

3.2.1.8 Miscellaneous Issues.

a) If we postulate that the simulators are going to improve, we must remember that the part-task trainers are going to want to interoperate also.

b) New areas in correlation were discussed. Stand alone simulators are always in the context of what that machine perceives. This also applies to networked simulators. This will lead to increased specifications.

c) It was suggested that a group of interested persons look at the reports and identify high level issues. A consensus must be developed since presently there are no formal requirements.

3.2.1.9 Conclusions. The session came to a conclusion with a summarization of activities.

3.2.2 Dynamic Terrain Subgroup. This group discussed the following issues related to dynamic terrain:

[The tapes from the first session on dynamic terrain were inaudible.]

3.2.2.1 Important Attributes of Dynamic Terrain. The session began on Wednesday by creating a list of the most important effects of dynamic terrain. These include displacements, mine fields, tracks, destroyable structures, clouds and gas, water problems, and wear caused by man-made machines.

3.2.2.2 Should Terrain Be Animated? Next, there was discussion on the relevance of the dynamic terrain being animated or going from one state to another. For example, should you see a bridge falling, or should it go from operable state in one frame to inoperable in the next?

3.2.2.3 Questions to be Addressed. Several questions were brought up, and the group agreed that those type of questions need to be addressed:

1) How does one simulator keep track of the interaction that another simulator is performing at a point not visible to

him? One possible solution offered was to have the common database in memory and have a list of dynamic changes that are going on elsewhere in the database. When the simulator comes within range of something on the list, then update the database at that time.

2) When someone new joins the simulation, do you need to continually broadcast the list across the net, or should you broadcast the list when someone notifies you that they have come on the net? The idea of one central history keeping unit for the database was offered. That way, when someone new joins the simulation or someone loses their data and needs to be updated, the central unit is there to supply the information. However, this presents network bandwidth problems for the CIG. In the near future, there is going to be too much traffic for the CIG to handle. Therefore, there must be redundancy in order to implement this history keeper.

3.2.2.4 Voice Communication Across the Network. The people in the tank have the capability to be updated on the status of the database much faster than the database updates itself, depending on the distance from the point in question.

3.2.2.5 Complexity of Terrain Effects. Different types of terrain effects can be stored in different locations and at different complexities according to their own complexity. For example, craters involve much more detail than blown up buildings. There are also different levels of the same affecting factors, i.e. how dense is the fog, etc.

3.2.2.6 Environmental Conditions. A major factor is how to implement environmental conditions created naturally versus those that are manmade. For example, flooding after a rain versus flooding after a tank blows apart a dam. One can be called before the exercise begins and the other would have to be a dynamic type of flooding.

3.2.2.7 Conclusion. The group discussion concluded with the general agreement that many types of dynamic terrain must be accounted for, whether natural or manmade.

3.2.3 Unmanned Forces Subgroup. This group, chaired by Mr. Dexter Fletcher of The Institute for Defense Analysis, discussed the following issues related to unmanned forces:

3.2.3.1 Objects to be Placed on the Terrain. Exactly what types of objects will be placed on the terrain? To answer this, you need to have knowledge of the accuracy level of the terrain, multiple representations of the database, and a high fidelity interface.

3.2.3.2 Semi-Automated Forces (SAFOR) Simulator Issues. The following points were discussed about the SAFOR Simulator:

1. What kinds of information does a SAFOR simulator have? For example, how much information is there, where is it located, where does it come from, and how does the semi-automated force make decisions pertaining to the terrain (such as the depth of water when approached by the tank.)?

2. An important factor is designing the semi-automated force so that it doesn't have an unfair advantage over the manned force.

3. How does the SAFOR interpret an object that is partially concealed? Several priorities were listed, including having a representation on the database that will allow the unit to make calculations and the ability of the unmanned forces to take advantage of humanly perceived cues such as the sight and sound of an explosion.

4. One suggestion was made that a thermal factor could be involved in the model of all objects on the terrain so that each object would have a certain thermal factor, and would make it easy for the SAFOR to calculate his actions.

3.2.3.3 *Day's Conclusion.* The session concluded with the participants agreeing that not much was accomplished because terrain issues have not been resolved.

Wednesday, 17 January, 1990

3.2.3.4 Interim Databases. Juan Perez of Engineering Topographic Laboratories opened the day with a discussion on Interim Terrain Databases (ITD). ITD is a tactical level product to support the Army. The contents of the ITD are in different levels, including sludge, drainage, soils, obstacles, vegetation and transportation, and each level is a separate file on the ITD tape.

The structure is a vector database that uses DMA feature files for attributes. Some of the applications for the main user are listed in the view graphs. Other applications are map background, mission planning/training, and threat analysis.

ITD is a subset of Tactical Terrain Data (TTD). The TTD combines the information from ITD and other sources to form a single product. It utilizes elevation information at level two at a higher resolution. ITD is derived from digitizing using 1950 technology, whereas TTD is derived from modern technology.

3.2.3.5 Project 2851. Mr. Tony Delsasso, project manager for Project 2851 (USAF), discussed the progress of Project 2851. Production of the data has not started yet, but should be under way in the first quarter of 1991. The Rapidly Reconfigurable Data Base (RRDB) project at PM TRADE has merged with 2851 to expand 2851's capabilities.

Problems that need to be addressed by Project 2851 are 1) correlating multiple image generators produced by different vendors; 2) global dynamic database updates; 3) support for autonomous vehicles (pre-programmed); and 4) integrating command and control system simulation. All of these problems can be boiled down into correlation (or lack thereof) among the nodes of the network. However, perfect correlation is an unrealistic goal.

From Project 2851's view point, application for simulated networks is within reach (to a certain level) and the mechanism to do it is available. As far as the database update goes, if everyone knows the different representations of the database, it should not be a problem to incorporate. One area that cannot be supported at this time is pre-programmed paths for autonomous vehicles. Certain vehicles with pre-programmed scenarios are not incorporated into Project 2851. Special effects like muzzle flash, smoke, and flame are also not incorporated into the project. Currently, no representation of the ocean is included in the program.

The map sheets should have a very high correlation with the database. They want a generic terrain, so that the training soldiers don't become familiar with the area.

3.2.4 Interim Databases Subgroup. This group discussed the following issues related to interim databases.

3.2.4.1 An Indexing Structure. Interim terrain databases need to consider an indexing structure for terrain databases to create a kind of synthetic map. This will allow you to find out the terrain characteristics at a certain point in the database.

3.2.4.2 How to Maintain Situational Awareness. The creation of a tactical awareness map index that incorporates geometric as well as semantic indexing can be used to accomplish this. If a centralized model of the ground truth is considered, we can imagine some sort of replica to use to maintain local tactical situational awareness within the SAFOR.

3.3 Terrain Databases Working Group Reconvened.

The Terrain Database Working Group reconvened on Wednesday to share information gathered among the sub-groups. Following are the summaries for each group:

Correlation. Dr. Duncan Miller summarized the important points recognized in the correlation sub-group. These included:

a) Minimize visual anomalies that might destroy the whole illusion of the simulation.

b) Maximize line of sight correlation and the similarity of the visual representation.

c) Determine the goals of the individual exercises in order to answer these relevant questions.

d) Use symmetries as a way to evaluate correlation.

e) Use statistical correlation of intervisible poles from different database renditions as one measure of this evaluation.

f) Determine the probability of:
- finding a target as a function of range
- correct friend identification
- foe identification of target as a function of range
- a hit as a function of range

These probabilities could be used in comparison to other statistical data.

g) Use handling characteristics for aircraft issues and their relation to the Cooper Harper rating as a building block for rating present day database interoperability.

h) Define data structures. Interoperating image generators of differing capabilities means the world cannot be rendered any more complex than the least capable generator is able to render. This rendering issue is possibly more of a human factors issue.

i). Develop a database in a neutral non-proprietary form for long term distribution of SIMNET databases. The central source for this is Project 2851.

Dynamic Terrain. Mr. Richard Moon summarized the conclusions of the dynamic terrain sub-group:

a) Dynamic terrain needs to be defined.

b) Lack of user input is a problem that needs rectification. One way to solve this problem is to recreate the simulator world from its beginning. First, the effects that people want to see would be listed on paper. Some of these effects would include earth mounds or holes (the desire to move the

earth), mine fields, craters, tracks from other vehicles, destroyable structures, bridges and buildings, gaseous clouds, environmental clouds, and water (flooding). Basically, any changes to the environment from human interaction or natural effects would be included. Limiting these to the most important yield destroyable structures, earth mounds or holes, and possibly tracks or craters. A further defining of these areas results in their categorization into man-caused dynamic effects and nature-caused dynamic effects.

c) The original brief defined some 12 topics with regard to terrain databases. A brief review of these topics was given, along with progress in the area.

d) We need to increase the size of the game board.

e) Development of correlation parameters in metrics is a means to improve interoperability.

f) Dynamic terrain feasibility/methodology is an issue. Some topics requiring government action include interim terrain data assessment, Project 2851 engineering change proposal assessment, coordination with Defense Mapping Agency, etc.

g) The definition of solid modeling techniques and the definition of texture representation were briefly mentioned and were spoken of with reference to Project 2851's progress in these areas.

h) Issues beyond terrain are common among many of the working sub-groups

i) If we imagine that there was some sort of long term database created as for a "God's eye view", then some sort of briefing mechanism would be needed to bring new players up to date in the simulation.

At Mr. Moon's conclusion, other comments and suggestions were invited.

Unmanned Forces. This group's discussion centered on putting distinctions used for generality within the vehicles' databases as opposed to between vehicle communications. The following list summarizes topics they discussed:

a) Higher Standards of resolution.

b) Clearer objectives.

c) Dealing within the vehicle database requirements.

d) The need for each vehicle to understand the terrain.

e) The necessity for universal threat specifications development.

f) The need for sensor data independent of the terrain.

3.4 Conclusion of Terrain Database Group.

Additional comments on representation of absolute vs. relative time and interpretation capabilities were given as well as concerns about the vague statement of making room for sensor data.

4.0 COMMUNICATION PROTOCOLS WORKING GROUP

Tuesday, 16 January, 1990

4.1 Opening Comments.

Dr. Ron Hofer of PM TRADE opened the session by defining the Communications Protocols group's purpose, which is to describe a standard that allows an open design architecture. This group, he said, is to look at processes which exchange data between simulators on the network, as opposed to processes that operate on data within each separate simulator site. Also, matters that deal with global correlation across the network such as time synchronization need to be addressed.

Dr. Hofer then introduced the sub-group leaders:

1. Tom Nelson: Inter-simulator Interfacing Methods
2. Joe Brann: Time/Mission Critical Parameters
3. Gene Wiehagen: Wide Area Network Connections
4. Jack Thompson and Bill Harris: Non-visual/Security Parameters

4.2 Opening Presentations.

Opening presentations were given on interfacing simulators, data semantics, time management, system architecture, SIMNET, wide area interconnection standards, and standardization of threats.

4.2.1 Interfacing Simulators. Mr. Richard Weatherly of Mitre Corporation spoke about interfacing simulators. DARPA is interested in distributed wargaming at the command post level, and specifically in things that are going on at the W.P.C. The Mitre Corporation has been asked to look at the general problem of interfacing simulations at this level (Naval Games, Ground Combat Games etc.). DARPA wants the simulations to work together to increase the functionality and avoid re-writing. This is a complex problem because separate communities each have divergent goals. The work that has been done on interfacing was done ad hoc, each with different purposes and exercises.

In order to organize the discussion, Mr. Weatherly broke down the interfacing problem into three dimensions: data semantics, time management, and system architecture. Mr. Weatherly then went on to discuss each particular dimension.

Data Semantics. As applied to simulation, Data Semantics is the study of the meaning, composition, and representation of the entities that are being simulated. The only entities to be concerned with are the ones that can be perceived or controlled by the user. These are not the guts of the simulation, but the only things that have some human concept. The meanings of things are usually represented by a name and a collection of attributes.

The interpretation of attributes themselves, of course, rely on some context. The problem is how to minimize the amount of this context to be exposed, and how to get two simulators to understand what is being talked about.

Time Management. Time management is concerned with advancing the simulation clock. The scheme is primitive. Mr. Weatherly discussed the three different ways to advance the simulation clock: time stepped, event driven, and continuous time. This is critical in determining the next state time.

Systems Architecture. Systems architecture is concerned with things such as where the data comes from, where it is going, where it is stored, and what hardware you have and how it's connected.

4.2.2 SIMNET. Mr. Weatherly then discussed SIMNET.

4.2.2.1 Attributes. In SIMNET, every entity has public and private attributes. The private attributes of an entity are stored by its owner uniquely and nobody cares. The public attributes of an entity are stored redundantly throughout the network and are maintained by dead reckoning algorithms. BBN proposes to implement these algorithms as part of the standard.

4.2.2.2 Time Management Scheme. The time management scheme for a SIMNET configuration is continuous-real-time. Therefore, the rate of time has to be advanced to allow for a different displacement. For example, SIMNET allows one module within the environment to believe it's midnight and another to believe it's noon, as long as they see time advance at the same rate.

4.2.2.3 Interface Problems. One problem is organizing different codes on different machines to form a configuration. This might cause a software maintenance problem. Another problem is the aggravation level. Some of the entities that these high level games are simulating are parts of the military command structure: they are moving corps and battalions and such, and have a much different behavior than vehicles. Another example is a logistics model like RAPID SIM where the entities that are being manipulated are undifferentiated material.

4.2.2.4 Partitioning. In the architecture issue, there is a potential scale problem. Some kind of partitioning mechanism is necessary. The concern with partitioning is two-fold: communication and computation. In communication, there needs to be gateways to make sure update messages don't go to people who don't need to hear them. In computation, this almost depends more on who's out there than it does on the individual simulator, because it has to run a dead reckoning algorithm and process update messages for everyone that is out there. The simulator is responsible for keeping the current truth of the world. (If a

better job of partitioning is not done, then you'll be condemned to having the computational horsepower of each given node, directly related to the size of the exercise it's participating in.) There are a lot of schemes that describe how to partition things, such as by geography or by unit ownership. It will probably take both.

4.2.3 Abstract of the Wide Area Network Interconnection Standards Presentation. Dr. Ron Hofer next gave an abstract of the wide area network interconnection standards presentation. The presentation was concerned with what kind of long haul communication links are needed. In a real sense, he said, these are being defined regardless of the protocols at the local network level. Some of those are invariant and they must be factored in the way the rest of the world is proceeding.

4.2.4 Evolution of Government Standards. Mr. Al Kerecman, Army Communications and Electronics Command (CECOM), gave the next presentation on the evolution of wide area network interconnection standards. He stressed that SIMNET can be something that provides interoperability not only to the Army, but also to the Air Force, Navy and Marine Corps.

4.2.4.1 Configuration Management. Mr. Kerecman stressed the need for a structured approach to Configuration Management. There needs to be some kind of coordination among the various communities. Under the large Configuration Management (CM) umbrella are things like the FTS 2000 that will provide most people with the services that they need. This effort is being mandated to the DoD community by Congress and is currently being implemented. Configuration Management handles lease line services, data voice, video and the like. Therefore, we have to keep in step and implement.

4.2.4.2 Model Standards. The International Organization for Standardization/Open Systems Interconnection (ISO/OSI) model is used to a large extent. Government OSI Profile (GOSIP) is a subset of OSI, and Computer Aided Logistics Support (CALS) is a network that is going to provide E.D.I. and O.D.A. type services for the bases across the country. Because we all need the same kinds of services, we need to use those services effectively and implement the same protocol profiles to be more efficient and cost effective in getting the job done.

4.2.4.3 Command Interest. Mr. Kerecman described areas of command interest including Configuration Management and Control, Conformance and Interoperability Testing, Application Software, Database Management, Network Administration, Network Management, Network Control and Security.

4.2.4.4 Protocol Profile Evolution. Mr. Kerecman then discussed Protocol Profile Evolution possibilities. There are different

directions that can be taken that need to be addressed: Either ISO 8802-2 type 1 can be evolved into an 802.3, or type 2 can be evolved into an Fiber Distributed Data Interface (FDDI) configuration. ISDN is coming along and all of these concepts need to be brought together at some time in the future. That evolution is possible if we make sure that SIMNET is specified along the various layers of the ISO chain.

4.2.5 Standardization of Threats. Mr. Stu Gibson of Naval Air Systems Command (NAVAIR) made a presentation on the standardization of threats. He sees the future of aviation simulation operating between multiple sights with multiple trainers. He discussed the Tactical Environment System (TES), and addressed the need for a realistic environment representative of the real-voice world. How does one tell what frequency is being played on, and who can talk to whom when there are multiple networked simulators?

Mr Gibson also stated that in order to have a realistic environment, you have to have a universal threat system with a current threat. Mr. Gibson is trying to take the threat data in models and algorithms and run them through interactive rules to provide standard threat models. He defined a threat as anything that stimulates a sensor on the aircraft. The threat system needs to be interactive and be able to handle the large amounts of data that are sent in an aircraft simulator. It also needs to have some system of updating the current threat.

4.3 Subgroups.

After the opening presentations, the Communications Protocol Working Group broke up into the subgroups of: Interface, Time Mission Critical, Non-Visual/Security, and Long-Haul/Wide-Band.

4.3.1 Interface Subgroup.

4.3.1.1 White Papers. The interface group began with Sam Knight, Jerry Burchfiel, Ray Fitzgerald, Chris Pinon, and Jorge Cadiz giving presentations of their white papers.

Mr. Sam Knight of CAE-Link. Mr. Knight discussed two topics from his paper "Issues Affecting the Networking of Existing and Multi-Fidelity Simulations": interoperable simulations and maintaining work loads. Some points he made were:

1. In some cases, identical databases are needed. Project 2851 is addressing the possibility of everyone using the same databases.

2. You cannot oversimplify a simulation if the work load is important. This brings about negative training.

3. Create a governing body that will decide who, when, and what will be on the network.

Mr. Jerry Burchfiel of BBN. Mr. Burchfiel gave a presentation of his white paper entitled " Use of Global Coordinates in the SIMNET Protocol." A discussion of this paper is given in Vol III of the Minutes.

Mr. Ray Fitzgerald of E&S. Mr. Fitzgerald discussed his white paper entitled "Position Paper: On Adopting the SIMNET LAN Protocol as the LAN Standard." He was concerned about sending matrices across the network instead of the Euler angles. If you send a matrix at Fourier heading pitch and roll, you are making it difficult for the vendors who deal with Euler angles. Time correction then becomes very difficult. Most CIGs do extrapolating at the front end level with Euler angles, so by sending the matrix you create much more work than necessary.

Mr. Fitzgerald then discussed removing static information from the SIMNET vehicle appearance PDU in order to decrease traffic on the network.

Miss Chris Pinon of IST. In her white paper entitled "Position Paper: On the Definition of Object Types in SIMNET Protocol," Miss Pinon stated that IST has examined the SIMNET protocol as a base line standard, dealing specifically with the simulation and data collection protocols. The object type is not a PDU, but a field in several PDUs used to describe the different objects in the simulation. Right now it is a 32 bit integer, but she proposes to extend it to a 64 bit integer to allow more possibilities for vehicles. As the battlefield size increases, there will be more vehicles and the extended bit fields will allow for this growth.

Mr. Jorge Cadiz of IST. Mr Cadiz presented his white paper entitled "Position Paper: Proposed Changes to the Vehicle Appearance PDU." In it he stated that the appearance PDU commands the majority of the network traffic. He recommends allowing for future expansion of the network. He also said there is a need for either an expansion or a reorganization of the PDU if the field is going to be expanded. He proposed removing the static information to deal with time critical needs and network bandwidth.

4.3.1.2 Focus on Simulation Protocols. Mr. Michael Sabo of SSDS spoke next. He stressed that this group needs to focus on the simulation protocols and not the association and data collection as a whole picture. These may end up hindering the forward movement of the group. The data collection protocols should run on a datagram service.

4.3.1.3 Prototype of an Air Combat Simulation Network. Mr. Jim Dilly spoke next on the rapid prototype of an air combat simulation network. The idea was to evaluate SIMNET on other hardware and see what kind of problems would be encountered.

In the test, reconfigurable crew stations were used, including distributed microprocessors. The full engineering simulation was rehosted on a VME chassis using parallel 68030 based processors. The visual system had to talk to the host and a separate ethernet line went out to the visual system. A battle over a long haul gateway between the two different systems was performed.

Mr. Dilly then discussed the results of the test:

a) A significant effort is required on the simulation side of the interface, but if you write the two codes more alike this will help considerably.

b) There were a few problems with transformation matrices and a problem with the trim on the aircraft-- the architecture had to be changed.

c) Non-homogeneous frame time gave some problems, but was easily corrected. A non-classified system was used to keep the bandwidth down.

4.3.1.4 Battle Force In-Port Training (BFIT). Next, Mr. Tom Tiernan discussed the Navy's BFIT program. Its objective was to do something achievable within a certain time frame and then evaluate the technology that was available at that time.

The approach taken was to evaluate the potential for SIMNET. Using SIMNET tanks and helicopters and two Aegis cruiser mock-ups, a gateway was used to process the PDUs from the SIMNET world

and translate them into Navy training signals that the video signal simulator could interpret.

They found that many PDUs needed for Navy application are missing in SIMNET. This does not mean that SIMNET is not usable, merely that the PDUs need to be expanded. For example, the vehicle appearance PDU was very easily adaptable for Navy applications.

Mr. Turney concluded that the SIMNET architecture using the VME bus was very effective. The integration with existing systems was the biggest problem; the protocols were far easier to adapt to the new systems.

4.3.1.5 Summary. The interface session concluded with the group trying to reach some decisions:

a) The idea of using a geocentric cartesian coordinate system was agreed upon, but there was still some opposition on whether 32 or 64 bits should be used.

b) Splitting the vehicle appearance PDU into two separate PDUs was discussed. The idea of cutting out certain static functions of the appearance would be removed and placed into a initialization PDU which is transmitted only at certain intervals. This would cut down on the network traffic. This topic was not agreed upon and people will be working on other options/approaches to the packet load on the network.

c) The Euler angles vs. matrix elements as orientation mechanism was not agreed upon, and this too will be kept open and addressed at a later time.

d) There was a discussion of a hierarchical layout for the PDUs, and a position paper will be submitted.

4.3.2 Time Mission Critical Subgroup. The Time Mission Critical subgroup discussed the following topics:

4.3.2.1 Time Stamping. The first speaker to the day, Mr. Dave Lawson of McDonnell Douglas presented a position paper entitled "Absolute Time Stamp in Networking of Simulators", written by Dr. Amnon Katz of McDonnell Douglas. Network delays, he said, can be avoided by synchronizing the simulation clocks, but the problem increases in complexity for long haul networks. The solution is to stamp the data as it is generated, with the initial and final frames to be synchronized. For clock synchronization, Mr. Katz recommends that the National Bureau of Standards transmit times out of Ft. Collins, CO. The time can then be received through a Heathkit receiver, and can be figured precisely.

An open panel discussion followed Mr. Lawson's presentation. One of the major problems with Mr. Katz's time stamping procedure is that absolute time stamping may not actually eliminate delays. Also, the updated time obtained does little to help synchronize the parts of the network, and feedback delays can't be predicted.

4.3.2.2 Debate. An informal debate took place addressing the following topics:

- Accommodating higher order dead reckoning models
- The necessity of absolute and relative time stamping
- Decoupling the implementation and standards

The goal is to provide, in ETHERNET application, a means to accommodate prioritizing traffic. This will take care of the delays and improve the scope of SIMNET.

Wednesday, 17 January, 1990

This session started with a summary of the recommendations made on Tuesday.

4.3.2.3 Position Papers.

1. Mr. Ray Fitzgerald, E & S, presented his white paper entitled "Position Paper: On Adopting the SIMNET LAN Protocol as the LAN Standard." The point of his paper that was relevant to this sub-group was the accuracy of time stamping.

2. Mr. Gary George, CAE Link Flight Simulations, made the next presentation of his white paper entitled "Time/Mission Critical Issues for Networks of Simulators." Mr. George's main point was to discard the SIMNET dead reckoning method because it doesn't work. He made references in regard to latencies and update rates, and stated that the technical accuracy has to be increased because of the high mobility of the aircraft. Examples included mid-air refueling and target hand over.

4.3.2.4 Prioritization of Data.
Mr. John Stoutson discussed the prioritization of the data. There must be the capability to handle high velocity and high acceleration vehicles, including C^3I and voice digitization. Messages can be sent by the system to signal that the channel is occupied by the transmission of data. Stations that need to send data can check the availability of the channel by sending a message. This way, the network communications can be improved without purchasing additional equipment.

Prioritization requires the development of a standard. The advantage is that implementation is inexpensive bit wise. ETHERNET can implement ways to indicate collisions and avoid them by utilizing a back off algorithm.

Effective station distribution can decrease queuing delays. A station's vulnerability to collisions depends on its position in the network. Stations that are farther away are more vulnerable.

Combining digitized voice on the network has tight requirements. The back off algorithm can be adjusted so that voice data is prioritized only after the first collision has occurred. It is also possible to favor some stations by increasing their persistence number.

4.3.2.5 BFIT. Next to speak was Mr. Tom Tiernan of the Naval Ocean System Center, San Diego. Mr. Tiernan is the technical directing agent for the program "Battle Force In-Port Training,"

(BFIT) originating in Norfolk, Virginia. His talk included a presentation of some of the findings of this program. The concept evolved around the philosophy of having battle group commanders and staffs manning the scenarios aboard ship as would occur during an actual situation, thus forcing decision making and effective tactical evaluations. SIMNET offered the interactive and integrated war fighting skills that the Navy had not previously provided. This freeplay type of exercise increased training by a large degree. Looking at these ongoing technologies, SIMNET offered the most in imagery technologies and networking protocol. Through their studies, they came up with a concept paper involving them in the standardization process.

In the future, a data bus network will provide forces in remote areas to be accessed. A new ship construction has been put on the platform. The LHD1 is being built and has been accepted by the Navy. Some embedded training capabilities have been capitalized on in the construction. The actual implementation utilized a butterfly as a gateway into the wide area network. Advanced Peripheral Units (APUs) were implemented in the mock up at Fleet Combat Training Center Atlantic (FCTCLANT). The PDUs come into the APU. Three PDUs are digested by the APU which transfer the information from the SIMNET world into the Navy world and the Navy Tactical Data System (NTDS). For example, a helicopter leaving the beach will appear as a radar return on the scope for individuals to take actions on their TDS console, entering information such as speed, identity, engagement status, etc. The APU was the key to interfacing with the outside world, and was made easier because the PDUs are very similar to the Navy packet.

Security Issues. Security issues were then discussed. The red and black (encrypted) data of the Navy operation had to be separated. They physically separated the hardware that processes the black data and the hardware that processes the red data. From here they made an interconnection to provide a picture.

BFIT Summary. A lessons learned summary touched on engineering aspects including the success of the butterfly computer and of the stealth vehicle. Aircraft graphics were projected and seen very well. The APUs were functional, with interfacing being completed with success late in the program. More tests and debugging are necessary for future efforts. Keeping the red and black data separate also needs additional research. Monitoring devices will be used, becoming procedural. It will be up to each individual how he uses the cryptos and trusted software that is classified. Data and voice networks and hardware connectivity were provided by BBN. A two to one voice compression was quite successful. VxWorks hosted on a Unix OS and VME bus performance were all strong points of the program.

4.3.2.6 SIMNET on non-SIMNET Devices. The next speaker to take the floor was Mr. Jim Dilly from McDonnell Douglas. Mr. Dilly's presentation included sharing some of the experiences of distributing the SIMNET protocol into different machines.

BBN, Paragon, and McDonnell Douglas Flight Simulation group worked in conjunction on the project with several purposes, including testing the SIMNET with high speed aircraft, not slow moving tanks. BBN's purpose was to demonstrate that the SIMNET protocol could be put on a non-SIMNET device. Also, BBN wanted to see what kind of problems would occur by integrating SIMNET into an existing simulator designed before SIMNET, and closing the loop using hardware integration for the F15 and F18. The design of the system included a VME 68030 based distributed processor system to host the SIMNET code installed by BBN. They encountered software problems in rehosting the language because of the different architectures. Where the SIMNET code is processed by the CIG, and the host needed to talk directly to the SIMNET. Also, the SIMNET architecture runs on an operating system, whereas this project ran on bare board target processors. An overall system integration in St. Louis of the three nodes, the F15, F18, and a threat simulation, was accomplished by BBN. The simulation also proved successful during long haul hook ups from Cambridge to Fort Worth. An overall lessons learned discussion was then given for the McDonnell Douglas project.

4.3.2.7 Summarization. A summarization and recommendations period followed. Issues mentioned were:

a) machine dependency, including big endian vs. little endian

b) floating point conversions

c) byte ordering

d) string manipulation

e) prioritization, etc.,

f) recommendation for the establishment of a standard for data representation

g) presentation of some basic issues that the group will address will be presented on the floor in the group recombination session later in the day.

4.3.3 Non Visual Subgroup.

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4.3.3.1 Attributes of Navigational Facilities. Mr. Gary George of CAE Link addressed the sub-group on the attributes of navigational facilities. Team training will require simulators to have common navigational facilities, he said, especially between different types of simulators. Earth models, flat earth, and velocity coordinated were discussed in accordance with team training and mission rehearsal.

The completion of the Global Positioning System (GPS) satellite navigation project and its long range uses were examined, and a commonality in the simulation was emphasized. The best alternative seems to be in the direction of look up tables for GPS simulation. Magnetic variation between modeled simulations is a present problem that needs to be addressed.

Environmental effects (wind, temperature, pressure, etc) and weather simulation were briefly mentioned as basically non-researched areas. A correlation is needed between simulations as far as weather conditions are concerned, whether its on a single node of a network or on an individual basis.

Mr. Steven Schwalm, CAE-Link, added his comments on the issues of updating new players in current exercises, identification of changeable objects in the simulated world, and a continuum on non-visual environmental effects. The study of the feasibility of an environment database manager, and updating new players on current environmental conditions were his main concerns.

Mr. George delved into several issues concerning aviation simulators. The fact that more information must be processed at a faster rate due to the complex nature of the aircraft at high speeds and varying mobilities emphasized how critical in-flight tactical decision making is. A study on the performance of latency and update rates to determine requirements of networked simulators, as well as consideration of the interaction of high and low bandwidth networks linked via smart gateways, were discussed. He concluded with a brief comment on the need for visibility correlation for out-the-window sensors and weapons, and the future move towards a universal navigation system for the improvement of team training simulations.

4.3.3.2 Follow-up Discussion. Follow up discussion issues included:

a) absolute time stamping in networking of simulators
b) compensation for communication delays over local and long haul links
c) vehicle position extrapolation
d) effects of variable delays of time stamping
e) absolute time stamping
f) clock synchronization
g) timestamp accuracy.

4.3.3.3 Security Issues. Security issues were discussed next. DoD standards of C and B level (or a "need to know" level of clearance) were distinguished as the important levels of trust in this particular area. Criteria laid out for these levels are addressed by policy. Some criteria are how to implement the security, accountability, how to make sure the policy is carried out, assurance, evaluation plans, and documentation. These security issues were related to the multi-level structure of the SIMNET PDU and the potential confusion this may cause. Each PDU must be modified to include its label of classification. The intelligent gateways could then determine which information would be allowed to pass through.

Review of current plans for unsecured operations produced a discussion of weaknesses and tendencies in the areas of tactics, weapon characteristics, and mission rehearsal. Also discussed was the problem with mixed mode operations, and the different security level datum on operating networks. This also creates the problem of providing realistic threats to uncleared trainees.

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4.3.3.4 Wrap Around Simulation Programs. The opening speaker discussed his research in the area of "wrap around" simulation programs. "Wrap -around" simulation programs must be provided with all the stimuli around all of the interfaces when training or testing a particular tactical component. For example, for a command and decision system that you want to train people on, you would have to provide all of the stimuli that it would normally get from weapon systems, sensor systems, communications systems, etc. Thus, you "wrap around" whatever you are trying to test, train on, etc.

He related his work to some of the main non-visual issues being addressed by the sub-group and made a comparison of the "smartness" of the simulation to the tactical system. The simulation system would know where an Electronic Warfare (EW) emission came from, while a tactical system would not. A brief discussion about the battalion being some super vehicle with many pieces and capabilities introduced the idea that if everything is a vehicle, you can do anything with anything. These vehicles are an implementation which makes special cases disappear. Resources are exhausted by these special cases. SIMNET, as is, will not define object oriented hierarchies for vehicle systems as far as particle definitions go, as these are not inherent to the protocol.

The group then discussed a planned DARPA exercise in March with 800 - 1000 vehicles ensued. Shared concerns were expressed, emphasis being on the vast and complex new databases to be used.

4.3.3.5 Army Hawk Air Defense System. Mr. Dick Gagan addressed the sub-group on the Army Hawk Air Defense System, specifically the electronic system for identifying friend or foe and areas of radar jamming. He mentioned certain deficiencies in the original protocols for these areas, and discussed current capabilities and specifications of SIMNET in this area and how vital the fidelity needs to be for an effective and accurate simulation.

The capabilities and types of the foe's system and how accurately they can be identified in an environment of multiple networked simulators need to be defined. Computational power vs. interface slots was a key issue as far as bottlenecking of the system was concerned. The possible need for a new database in addition to the terrain database (possibly for air control) was discussed. The complexity of aircraft and the networked simulations themselves has defined a need for this added computer power. Finally, the group discussed the question of the compatibility of the SIMNET protocol with tactical communications command and control. For example, fuel transfers and missile reloads do not request the proper channels as would be expected. Rather, the "handshake" within the protocol makes this agreement within the whole command and control system. This is simply a definition within the protocol.

4.3.3.6 Neutral Forces. Final discussion of the morning was directed to the issue of neutral forces (objects) on the battlefield. Questions were raised as to whether this should be within the realm of this movement.

4.3.3.7 Issues of the P.M. Session. The afternoon session began with reference to limited access of information for various projects. Methods of the National Security Agency (NSA) were discussed with references to their electromagnetic intercept devices, policy, etc; Expectation is that interoperability solutions will increase the problem with security and privilege of access. Again, the multi-level architecture of a "smart" gateway was discussed as a possible future solution for multi-level security. Problems with this were explored with the stealth vehicle, for example, which would have the capability of disrupting a system without being seen. General multi-service security issues were then briefly discussed.

4.3.4 Long Haul/Wide Band Subgroup.

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4.3.4.1 Opening Discussion. After a brief orientation and background description, Mr. Wiehagen laid out the goals and areas of study the working group would be addressing, including the investigation of methods to connect geographically dispersed elements of a simulation or network arrangement and to perform training testing and evaluation. In order to achieve these

goals, he said, an agreement on the requirements (or services to be provided) must be reached and an assessment of existing and proposed military and commercial long haul capabilities should be performed. Shortfalls can be identified, and areas of research and development will be recommended. Four candidate issues were also identified. The sub-group was charged with separating the most important of these issues. Mr. Wiehagen foresees the long haul effort process taking more time than the PDU protocol process, partially because the requirement is not as urgent. Group comments seemed to indicate that there was some concurrence that the long haul effort should attempt to keep in stride with the PDU protocol effort.

4.3.4.2 Candidate Issues. Mr. Wiehagen proceeded to identify the candidate issues of which he had previously spoken. These issues were originally identified during the first Standards Conference. The development of a standard protocol approach for wide area communications long haul was established as the main issue for the subgroup. Commercially available hardware and its capabilities relative to the requirements (emphasis in the area of bandwidth), at home as well as abroad, was a key topic of discussion here. The goal of the system is to ultimately join the armed forces in the design of a "best case" scenario. The Joint Technical Coordinating Group (JTCG) and the Army Training and Doctrine Command (TRADOC) will need to define this requirement. Decisions will have to be made on whether or not to use existing commercial or military capability, how the models will handle it, and how to keep the numbers manageable. It is also necessary to know what to throw out and what is really needed to pass between the combined armed forces operation so that the network can be sized properly.

4.3.4.3 Voice and Data Communication. Discussion moved into the area of voice and data communications. To date, all SIMNET has done to handle voice communications is to use existing commercial phone lines. The number of voices involved has been small. Digitizing the voice signal may involve some complications in the area of geographically dispersed units. The simulated terrain and atmospheric effects must be considered. Accordingly, the voice and data information will be another driver in the bandwidth arena. This will be another area the sub-group will have to explore, and so far this seems to be a manageable problem.

4.3.4.4 Incorporation of Stack Protocols. Next, the topic of incorporation of stack protocols was explored. For the long haul commitment, the gateways between local area networks are the starting point for this incorporation of protocols. Incorporation of protocols for net and transport for the multicast was explored next. Some discussion centered around the filtering of PDU packet destination information at the gateway level of the network. The question was raised as to whether there is any room left in the individual packet to make some of

the suggested changes or enhancements. For certain manipulations, the packet will be undisturbed and the enhancement will take place at a different level of the architecture.

4.3.4.5 Day's Conclusion. As day one concluded, Mr. Wiehagen proceeded to urge members of the sub-group to take the initiative in authoring position papers on some of the candidate issues previously mentioned. According to Mr. Wiehagen, the issues inherent to this sub-group had been narrowed considerably, with the most significant being (1) PDU local interfaces (2) voice and data, and (3) imagery communications.

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4.3.4.6 Co-Chairmen. Mr. Wiehagen opened the morning session by announcing that two men had been nominated as co-chairmen. Mr. Al Kerecman and Mr. Steve Blumenthal from BBN were chosen to guide the sub-group during the first and current year of the standardization process.

4.3.4.7 Current Issues. Mr. Kerecman addressed the sub-group on his impressions of the current issues. Possible other considerations involving some upper layer protocols to be looked at are not the interactions with the environment in other simulators, and what kind of information do the simulators pass back and forth in real life. For example, does the F15 simulator exchange information tactically with other fighter aircraft, and if so, how? Also, has this been included in SIMNET to date? Mr. Kerecman feels that some of these points must be considered in the current process and included in the documentation therein. Comments on current software in the aforementioned area suggested that there are additional things, for example, a command and control point of view, that needs to be passed in a context that can be realistic. The importance will be emphasized in the interoperability of the SIMNET protocol which will allow for the ISO system standard. To come out with something that doesn't allow future SIMNET to adhere to would be a real mistake. Mr. Kerecman feels this is the main emphasis of the whole process.

4.3.4.8 Application of Gateways. Mr. Art Pope next addressed the group on the application of gateways. Discussion of the Internet Protocol (IP) and the desire to multi cast followed: Ethernet will support multi cast exercises, and FDDI supports broadcast and multicast. Therefore, a different specification for FDDI can be written. The problems with large numbers of vehicles and the correspondingly large number of packets on the network were examined. It is proposed that the network has no intelligence, but rather the receiver deems which packets are important. Within this were comments about the feasibility of having an intelligent gateway between local area networks to handle this dilemma. This is a consideration to be made after further research and development within this area.

4.3.4.9 Misc. Items of Discussion. Further items of discussion for the morning sessions included:

a) Definition of a present protocol profile mapping to the ISO profile. Within this, the factors of time stamping/latency and security must be examined, the latter by one of the other sub-groups. Mr. Pope recommended an ISO profile for the SIMNET specification and its impending evolution to FDDI/ISDN.

b) The consideration of the additional service requirements driven by the joint and the service doctrinal guidance, as well as the realization of the possible contributions that can be made by interactions within IST and ITS. The process must try to accommodate what NATO is doing for purposes of compatibility.

c) Consideration of Configuration and Integration (C&I) testing, verification and validation, and use of other network assets that are out there (MILNET, SCINET, etc), as well as whether or not a configuration management process is necessary to lay a baseline are important issues that must be carefully thought out before the process continues.

d) It would seem feasible to begin to structure a database to house all of this information.

4.3.4.10 SIMNET Simulation Requirements. A brief review of SIMNET simulator requirements was given to open the afternoon discussion. Topics of simulator interpolation of PDUs through lost packets, simulator transmission rates, voice and data digital specifications, networking requirements such as remote access, distribution of new software, exercise planning, coordination, and review were all briefed. DARPA has concluded that SIMNET should not have to build its own network. Requirements for communications types for different types of data, such as imagery, effects, sensors, and packet voice must be mapped in the new protocol.

4.3.4.11 ISO & IP. ISO and the IP were again discussed with reference and comparison to SIMNET. The opinion of the committee chair is that the ISO protocol doesn't provide some of the necessary services needed for the SIMNET application, and therefore the future evolution of the ISO protocol will be followed closely. Somewhere down the line the ISO protocols may be able to do the job in a cost effective way to bring about a compatibility with NATO. The requirements of SIMNET will need to be introduced to ISO, and from there an evolution within ISO can be met. Experiments within the IP can help in the definitions and applications of SIMNET so it can be implemented in an ISO environment. This seems to be the only current internet structure that can be manipulated in a way that resembles the ISO

interstructure. In conclusion, the sub-group decided that the game plan is ISO, not the present architecture. For the long term configuration management environment, recommendation will be for American National Standards Institute (ANSI).

4.3.4.12 Terrestrial Wide Band Network. Mr. Blumenthal next gave a presentation on the development of a terrestrial wide band network. The protocol supports dynamic multicasts, group addressing of packets, and a mixture of datagram and screen type data mixed together. The integration of voice and data has not been addressed in the protocol. The ability to support high speed networking tests on this network will be made available by a long haul gateway.

5.0 CLOSING SESSION

17 January, 1990

5.1 Opening Comments.

Mr. Brian Goldiez opened the session by establishing points of contact within IST and announcing that at the next conference findings will be reported as interpreted from the previous two conferences.

5.2 Communication Subgroup Summaries.

Each sub-group then presented a summary of their discussions, along with findings and recommendations for the audience.

Interface. Mr. Tom Nelson represented the Interface sub-group and they presented the following two resolutions:

a) The Geocentric Cartesian Coordinate System should be the reference frame for passing positional data.

b) The networking protocols and database standards that are being developed are not sufficient and an administrative mechanism is essential.

Time/Mission Critical. Mr. Joe Brann represented the Time/Mission Critical Parameters sub-group and they presented the following recommendations:

a) Keep the time stamp field in the protocol, but add another field to identify whether or not it is a relative or an absolute. Keep the least significant bit at suggested .838 micro sec.

b) Define a higher order vehicle class to support the higher order velocity derivatives in upgraded dead reckoning algorithms.

c) Establish explicit data representation.

d) Add a priority field to the PDU field, the value of 0 to be the lowest priority and 15 to be the highest.

e) Develop dynamic air criteria capability for aircraft simulators.

f) Provide control level PDUs (freeze, reset, reposition).

Non Visual/Security. Mr. Jack Thompson and Mr. Bill Harris represented the Non-visual/Security Parameters sub-group and presented the following conclusions:

Non Visual

a) Two papers that were looked at in the Non-visual area concerned navigational aids and VOR or satellite site.

b) The current protocol has minimal sensor and electronic warfare capability.

c) We need to expand the PDU to represent sensors of all types. The VOR should be approached in a dynamic terrain sense and be interactive.

Security

a) When unclassified information and encrypted classified information are transferred on the same simulation, information leakage is bound to occur. One remedy is to secure the exercise as a classified operation. Another is to use a special gateway to separate classified and unclassified information.

b) Each of the approaches has problems and the issue needs to be further addressed.

Long Haul/Wide Area Network. Mr. Gene Wiehagen represented the Long Haul/Wide Area Network sub-group and Mr. Al Kerecman spoke on his behalf from the technical standpoint. They developed nine points of discussion.

a) Security - Managing security at the gateway was a recommendation.

b) Definition of the present protocol profile and its mapping into ISO reference model.

c) Time stamping and the latency issue.

d) The recommended profile for the SIMNET specification. The consideration and participation with NATO.

e) The additional service requirements that are driven by the joint and service doctrinal guidance.

f) How to bring NIST, ITS, NTIA and university contributions into a possible evolution.

g) C&I testing and verification and validation of those simulators. (At what point will you say, this is SIMNET and this is the protocol profile?)

h) Database configuration and configuration management.

i) The belief that the present protocols are capable of being used as a platform for which IST and PM TRADE could go out with new procurement activities.

j) The belief that the present protocols are not evolvable, will not be cost effective, and will not be globally accepted and that there is a need for SIMNET to embrace the ISO community.

5.3 Terrain Databases Subgroup Summaries.

Mr. George Lukes presented the findings from the Terrain Database working group as a whole, summarizing that the main problems are related to correlation.

Updates. Three update presentations were made at this time. Mr. Juan Perez from Engineering Topographic Laboratory (ETL) Digital Concepts and Analysis Center gave the first update on the interim terrain data. The second update was given by Tony Delsaso, project engineer from Project 2851 at Patrick A.F.B, on the latest involvement and the emerging prototype of generic transform databases that will be available by the end of this year. Finally, Mr. Pete Weaver from BBN gave an update on the SIMNET database interchange specification.

Global Coordinate Systems. The discussion then centered around the use of global coordinate systems and conversion and approximating methods. The unanimous decision was to adopt the WGS-84 frame of reference as the standard, modeling for a spherical earth. The recommendation was to have x, y, and z represent the coordinates with respect to the center of the earth. However, the Army would like to use the military grid reference system on soldier machine interfaces. ETL is developing a handbook of conversion algorithms that is due to be published in April of this year. Other issues discussed included expanding the playing area.

Unmanned Forces. The Unmanned Forces (SAFOR) sub-group had the following recommendations:

a) Vector and point representation should be allowed and encouraged in the standard that is to be developed because polygons are not enough.

b) The future SAFOR objectives are still unclear.

c) The terrain database and the vehicle database need to be

expanded.

d) The standard should allow for object oriented databases.

e) The SAFOR standard needs to allow for a universal threat system.

f) The PDUs should contain sensor data.

Correlation. Dr. Duncan Miller presented the conclusions of the correlation sub-group:

a) You must minimize visual anomalies and maximize the line of sight correlation.

b) A third area discussed was experimenting with two simulators at the same point on a terrain database to see how well they correlated.

c) The correlation of images on different types of sensors is also important.

d) Operational measures like target detection probability and identification probabilities are going to make a substantial difference.

e) We need to find some way to quantify what we mean by correlation in order to determine how much correlation is enough.

[The group went over a couple of mathematical algorithms that measure point to point correlation on two different renditions of the same terrain.]

f) Even better computers will not increase correlation because there will always be low throughput image generators and high throughput image generators that will need to be correlated together.

Dynamic Terrain. The dynamic terrain sub-group reported a summary of their actions next.

a) Most of their time was spent trying to define dynamic terrain and how to approach the problem. The problem was categorized into two main classes: what man or manned vehicles cause and what nature causes. Then they listed considerations under each category, along with a list of what the industry was asking for.

b) Some issues should be addressed now, like the

destruction and creation of structures. Additional work is needed toward the expansion of the PDUs, allowing them to accommodate those sorts of things.

c) If you change the terrain, it is usually a permanent change and there is a need for someone to keep track of the history of these events for new players in the exercise. This historian should not be distributed among the initiators of those actions, but should be someone who can manage it centrally.

d) Some areas of interim terrain data assessment demand government responsibility. With regard to the ITD assessment, ETL is working with PM TRADE to investigate ITD related issues with regard to both Project 2851 and SIMNET.

e) DMA has the lead responsibility for standardization with regard to mapping, charting and geodesy products. At this point, we are looking for areas of information that pertain to this such as digital elevation information, feature information, solids models and texture maps.

f) Definition of solid modeling techniques was very lightly touched. Project 2851 is using constructive solid geometry as an approach to build a general model library within the Standard Simulator Database (SSDB). Initial implementations of that are to be included this Spring with the release of a generic transform database (GTDB) prototype.

g) Definition of texture representation was also very lightly touched. This is not yet implemented under Project 2851. It's proposed under the current expansion of the effort.

The SIMNET database interchange approach provides a near term opportunity to get existing SIMNET databases out in the hands of other users. We're relying on the Generic Terrain Database (GTDB) from Project 2851 as the primary mechanism to produce standard data sets within the community. The assumption is that Project 2851 will respond to the additional needs of simulation networking, including this variety of non-visual sensors.

5.4 Conference Conclusion.

The conference concluded with the end of these summary presentations.

6.0 GLOSSARY OF ACRONYMS USED IN THE MINUTES

APU	Advanced Peripheral Units
ANSI	American National Standards Institute
BFIT	Battle Force In-Port Training
CALS	Computer Aided Logistics Support
CECOM	Army Communications and Electronics Command
CIG	Computer Image Generator
DARPA	Defense Advanced Research Projects Agency
DMA	Defense Mapping Agency
DoD	Department of Defense
FTL	Engineering Topographic Laboratory
EW	Electronic Warfare
FCTLANT	Fleet Combat Training Center Atlantic
FDDI	Fiber Distributed Data Interface
GOSIP	Government OSI Profile
GPS	Global Positioning System
GTDB	Generic Transform Database
I/ITSC	Interservice/Industry Training Systems Conference
ISDN	Integrated Services Digital Network
ISO/OSI	International Organization for Standardization/Open Systems Interconnection
IP	Internet Protocol
IST	Institute for Simulation and Training
ITD	Interim Terrain Databases
JTCG	Joint Technical Coordinating Group
NAVAIR	Naval Air Systems Command

NIST	National Institute of Standards and Technology
NSIA	National Security Industrial Association
NTDS	Navy Tactical Data System
PDU	Protocol Data Unit
OSD	Office of Secretary of Defense
PM TRADE	Program Manager for Training Devices
RRDB	Rapidly Reconfigurable Database
SAFOR	Semi-Automated Forces
SSDB	Standard Simulator Database
TES	Tactical Environment System
TRADOC	Army Training and Doctrine Command
TTD	Tactical Terrain Data
UCF	University of Central Florida